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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/EP99/02820</p> <p>(22) International Filing Date: 27 April 1999 (27.04.99)</p> <p>(30) Priority Data: 98107675.5 28 April 1998 (28.04.98) EP</p> <p>(71) Applicant (for all designated States except US): ROBERT BOSCH GMBH [DE/DE]; Postfach 30 02 20, D-70442 Stuttgart (DE).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): DORENBECK, Claus [DE/DE]; Dammstrasse 21C, D-30938 Burgwedel (DE).</p>		<p>(81) Designated States: JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>
<p>(54) Title: METHOD FOR GENERATING AND INTERPRETING A LOCATION REFERENCE INSTANCE WITHIN A DIGITAL MAP</p> <p>(57) Abstract</p> <p>For generating a location reference instance within a digital map an object to be referenced is identified. The position of the object is determined by its co-ordinates, the object class to which the object belongs is determined by some or all of its own or related object attributes, and a descriptor comprised of information stored in the attributes of the object or related objects. For transmission purposes the position, the object class and the descriptor is coded in a given format. Within traffic and telematics applications this method is applicable as communication means between a service provider and user.</p> <div data-bbox="1161 1186 1372 1911"><pre>graph TD; Start([Start]) --> IdentifyObjects[Identify objects]; IdentifyObjects --> DeterminePosition[determine position]; DeterminePosition --> DetermineObjectClass[determine object class]; DetermineObjectClass --> IdentifyDescriptor[Identify descriptor]; IdentifyDescriptor --> Coding[coding]; Coding --> Stop([stop]);</pre></div>		

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10 Method for generating and interpreting a location reference
 instance within a digital map

Background of the invention

15 In the area of traffic and telematics applications the
 exchange of information relating to geographic phenomena
 has been difficult due to the low bandwidth (transmission
 capacity) of transmission media available. This has
 become quite obvious with the development of RDS/TMC
20 (Radio Data System/Traffic Message Channel) services. In
 order to relate any information on a specific part of a
 road network, the information itself and the affected
 location, i.e. intersection, stretch of road, etc., has
 to be communicated. The combination of information and
25 location, as well as time, is commonly referred to as
 message. Since the available bandwidth for transmission
 is very limited, messages have been coded. The chosen
 coding approach for locations is straight forward: a
 unique code is given to the location. This is an
30 arbitrarily chosen number or identifier which is assigned
 to specific, predefined locations. Several restrictions
 have been accepted with this approach:

- The set of locations which can be referenced is limited to the set which has been precoded and distributed in a look-up table.
- 5 • The code can only be decoded with a look-up table.
- Transmitter and receiver rely on exactly the same look-up table to decode a location.
- 10 • The code does usually not reveal any information about the geographic area being affected.
- Codes have to be maintained centrally, often on a national level.
- 15 Pre-defined location codes are very often limited to serve a specific application, e.g.: traffic information service.
- 20 EP 0798540 A1 describes a method for referencing fixed objects. Nodes within a grid structure are coded. With a reversible algorithm the nodes can be converted into a geographical coordinate system.
- 25 US 5107433 describes a method for inputting starting and destination points into a navigation system. Data of street maps comprise a street identification character and reference point coordinates. In a data storage inputted data is searched. When there is an agreement the
- 30 coordinates are taken over for navigation.

Current technology allows to store geographic maps in computer systems. A geographic map being stored in a computer system will be referred to as digital map or digital map databases. The content of a digital map can
5 be described as objects having a specific location in space. The location of an object in a digital map is usually described by means of a co-ordinate system, being a mathematical model referring to the x and y axis in space. Additionally such an object carries attributes
10 describing it in terms of a name and other specific features. The union of attributes and location are an object in a digital map.

Digital maps are produced for a wide range of
15 applications. Standardisation efforts of digital maps have been limited to data models for specific applications, such as the GDF [1] data model which is a CEN standard developed for and used in traffic and telematics applications. Various organisations produce
20 digital maps according to the GDF standard. However, there are some variations with respect to the level of detail and the content actually being captured. This results in the inevitable fact that even though digital maps are according to GDF they can/do slightly differ
25 depending on the producing organisation.

Most in-vehicle navigation systems use digital maps which have been captured according to GDF 3.0. In order to use the above mentioned approach on referring to a specific
30 location (e.g. an intersection) within the RDS/TMC service, a digital map producer would have to store the codes being assigned to any predefined location in

attributes of the corresponding objects. This results in a dependency of every map producer on the availability of the look-up table which contains the official code and the appropriate full description of the object.

5

Another method of location reference has been developed by the ERTICO Committee on Location Referencing [2]. The proposed method is called „Detailed Location Referencing (DLR) based on Intersection Location (ILOC)“.

10

Intersections in road networks are considered as the basic elements of reference. An ILOC is defined as an intersection identified by its centre co-ordinates and the first 5 characters names or road numbers of three of the intersecting roads. Every reference made is limited to the road network, which can be described by a single ILOC or combinations of ILOCs. Reference to other objects in a digital map is not possible.

15

Summary of the Invention

20

It is an object of the present invention to provide a method for generating a location reference instance within a digital map which allows a more efficient and universal form of referencing. The method of the invention allows to reference to objects independent of their positions within a digital map. According to the steps of claims 1 to 5 an efficient location referencing is achieved not limited by specific data structures or applications or predefined codes due to a strict differentiation between the positions and descriptors/attributes of an object as well as applying object-oriented data modelling.

25

30

In contrast of the aforementioned patent citations an object is not only referenced (coded) by a position but also by an object class and by a descriptor.

5

Brief Description of the Drawings

Figure 1 shows a flow chart of the method for generating a location reference instance,

10

Figure 2 shows a flow chart of verifying the location reference instance.

15

Description of the preferred embodiments

According to the invention a spatial object tag (SPOT) approach is used. This spatial object tag (SPOT) approach on location reference is based on an object-oriented approach to data modelling. The fundamental construct of object-orientation is the object which combines data structure and behaviour in a single entity. For better understanding, the following definitions are given:

20

25

Object: In this context an object refers to a geographic phenomena (e.g. a road, an intersection, etc.) described in terms of a position and attributes. An object can consist of several other objects (e.g. a set of road elements constitutes a road).

30

Object

class: An object class represents a certain concept of reality. Object classes can be
5 hierarchically ordered, i.e. an object class may belong to another object class if the represented concept is a refinement of the other. For example, intersections are an
10 object class, further refinement of the object class intersection results in sub-classes which may be freeway interchange and highway intersection.

Location: A location describes where a single
15 occurrence of an object within a digital map is situated. A location is always associated with an object. The location of an object can be described in either a single position or a set of positions.

20 Position: A position is the precise description of space in terms of a co-ordinate system. A position is at least a pair of co-ordinates. A position itself does not relate to
25 anything.

Attribute: An attribute is either a number or text or a combination, describing an object,
30 independent of its position.

Location

reference: Location reference describes an object in a digital map in a very condensed form, i.e. coded, allowing to identify the same object in another digital map, while taking slight variations in position and presentation of the object into account.

The SPOT location reference method relies on the fact, that an object in a digital map consists of two very different parts:

- The location of an object expressed as its position within the digital map.
- Attributes which describe the object regardless of its location.

Efficient location referencing, not limited by specific data structures or applications or predefined codes, is only possible if a strict differentiation between the position and the attributes of an object is made. Furthermore a classification of objects according to concepts applicable within traffic and telematic applications must be present. The classification needed for location referencing within traffic and telematic applications must be made upon doubtless information of reality.

When comparing a digital map from vendor A with one from vendor B, even if they are built according to the same principle (e.g. GDF) differences for precisely the same object can be noticed:

5 An object referring to the same geographic phenomena in reality may have different co-ordinates in different maps. The location of an object, i.e. its position, is described with co-ordinates. These co-ordinates are assigned to the object in the digitisation process. Digitisation can be done on the basis of a wide range of different sources such as satellite images, aerial photographs, topographic paper maps or cadastral paper maps. Since the resolution, i.e. the level of detail, of certain geographic phenomena differs with regard to the used source, the same object may be located at slightly different positions depending on the used source.

15 An object referring to the same geographic phenomena in reality may have different representations (different data models) in different digital maps. Even the GDF data model allows for variations on the representation of objects.

20 By means of location reference one has to describe a geographic phenomena represented as an object in a digital map and check/present the object representing the same geographic phenomena in a different digital map.

25 This can be done in two different ways:

An object can be referred to by its name (e.g. street name). This may lead to a rather large set of objects satisfying the requested name. Significant additional effort is necessary in order to find exactly the one object in question. It may even be possible that the object being searched for can not be found due to missing

30

or different relations within the queried digital map,
even though it does exist within that digital map.

Alternatively some sort of authority would have to assign
a specific name or identifier to all objects that shall
5 be referred. This approach is used for the generation of
RDS-TMC location codes.

An object can be referred to by its position, i.e. the
co-ordinates of the used digital map. Most likely this
10 object will have different co-ordinates in another
digital map, due to the digitisation process. A variation
of this method would assign the position of an object to
a co-ordinate of a fixed resolution. An object is
assigned to the nearest co-ordinate of a fixed resolution
15 co-ordinate system (e.g. 100m precise co-ordinate
system). In case two objects would refer to the same co-
ordinate, one is being shifted to another near by co-
ordinate. This requires pre-assigning co-ordinates to
objects (Reference to EP 0 798 540 A1 possible).

20 The existence of an object in a digital map depends on
the capturing rules being applied. The accuracy of an
object location depends on the capturing process. This
implies that if a location shall be referenced it should
25 be done by the position of the object instead of
attributes of the object. It must be assumed that the
transmitter of a location reference does not know,
whether the receiver has the object in question or how
exactly the object has to be referenced by means of
30 attributes. Using the position of an object and allowing
for a search area around the position in the receiving
digital map grants an unambiguous solution.

The following prerequisites have to be considered. The object exists in reality. The object is either captured in a digital map or not. Real world information associated with an object is either captured as attribute of the object or attributes of sub-objects. This real world information describes certain features and/or functions of the object. Parts of this information are sufficient to assign the object to an object class which represents some sort of concept suitable for traffic and telematic applications. The area within which the object in the receiving digital map should be located is known (by the co-ordinates of the object within the sending digital map). Of course, the used co-ordinate system must be agreed upon between sender and receiver. In some cases more than one object of a certain object class maybe located within the search area of the receiving digital map. Therefore, some additional information must be supplied to make the object unique within the possible set of objects of this class. This part of information, is called descriptor.

With regard to the location reference as defined before the following can be concluded:

25

- An object is either in the digital map or not.
- Referencing an object by its attributes can become difficult considering the fact, that variations of the data model and/or certain attribute values are possible.

30

- The position of an object may vary between digital maps, due to the capturing process. Therefore, location reference must support a spatial range query based on a given position in order to determine the existence and allow the presentation of the requested object. Actually the method for location reference according to the invention is based on the following proposition:

An Object Instance, i.e. a single object:

- belongs to exactly one object class
- has a position within a given digital map (which is its location)
- has attributes of its own or attributes of its sub-objects, allowing for classification according to object classes suitable for traffic and telematic applications.
- some or all attributes of an object refer to real world information.

The process of SPOT location reference between digital maps can be divided into three steps:

Generate the location reference instance, i.e. create a code consisting of a positional part, a classification part, and a descriptive part, for some geographic phenomena stored as an object in a digital map.
(in order to compact the location reference)

Transmit the location reference instance, i.e. the above mentioned code
(via any transmission media)

Verify the location reference instance, i.e. decode the transmitted code and interpret its contents in order to verify the presence of an object representing the same geographic phenomena as intended by the creator of the location reference instance.

(Find and present the object being referred to)

Verifying a location reference is a combination of retrieval methods of objects in digital maps. In order to determine the same geographic phenomena in a digital map of another map producer, the following components of a location reference instance will be generated, transmitted and verified:

POSITION: is the spatial description of a geographic phenomena stored in an object in terms of co-ordinates of an agreed upon co-ordinate system (e.g. WGS 84). The spatial description maybe reduced to a single co-ordinate, since the accompanying object class reveals the actual geometric representation, i.e. point, line, area. The position will be used to determine the centre of a search area in the verifying digital map.

OBJECT CLASS: is the representation of a group of objects, all satisfying a certain concept applicable within traffic and telematic applications. Each object class will be coded for efficient transmission of a location reference instance. The definition of an object class and its code must be agreed upon between sender and receiver. It is advisable to define object classes which

are based on doubtless information of reality (e.g. an Autobahn in Germany is determined by the officially assigned code "A" followed by a number). An object class is the abstract generalisation of objects regardless of the data structure or data model used.

DESCRIPTOR: is part of common information of an object (e.g. a street name). The common information to be used in a location reference instance is determined by the object class. For efficient transmission of the location reference instance, the descriptor may either be coded or represent only a small portion of the common information.

The SPOT location reference method is now further described using several steps.

Generation of a location reference instance:

In digital map A: This is the digital map being used to create the location reference instance of an object x (see flow chart according to Figure 1):

- Identify the object x which shall be referenced
- Determine the object class of object x
- Determine the position of the object x by its coordinates
- Identify the descriptor of the object x

- Code the position, the object class and the descriptor into an agreed upon physical format.

Transmission of a location reference instance:

5

- Transmit this code.

Verify the location reference instance:

10 In digital map B: This is the digital map being used to present the location which is being referred to (see flow chart according to Figure 2):

- Decode into position, the object class and the descriptor from the physical format into the system format

15

- Determine the centre of a search area by the decoded co-ordinates

20

- Search the digital map for objects representing the geographic phenomena being coded in the location reference instance:

25

Create the search area determined by the object class with a centre at the decoded position of the location reference instance. The digital map B is now split into two parts, the complete digital map and a small area within, being the search area. In the next steps only the content of the search area is of interest.

30

In most cases several objects of various object classes will be present in the search area. Determine for each object in the search area whether it belongs to the

object class of the location reference instance or not.
Those objects which are not part of the object class of
the location reference instance are being neglected.

5 All objects which are within the search area are
collected. If more than one object of the object class
of the location reference instance has been found,
compare each of these objects with the descriptor of
the location reference instance (verification the
10 decoded/given descriptor with attributes or parts
thereof of the collected objects). The object that
matches the descriptor represents the geographical
phenomena being referenced within digital map A in the
receiving digital map B.

15 Within traffic and telematics applications the method
according to the invention will be applicable as
communication means between service provider and user. On
behalf of the receiver a navigation system is perfectly
well suited to make use of the shown method. Additional
20 databases or look-up tables to keep location codes become
obsolete. Digital map producers who provide maps for
navigation systems do no longer need to store predefined
codes to enable traffic and telematic services to refer
to a certain object within the digital map of the
25 navigation system. In general the described method can be
implemented whenever location referencing of objects
between similar digital maps is needed. The method allows
to transfer the reference information of an object
through low bandwidth transmission media.

30

References:

- 5 [1] ENV ISO 14825 "Geographic Data File (GDF) 3.0";
Digital Map Database Standard (data model, data
dictionary, exchange format), CEN/TC278; 12 October 1995.
- 10 [2] Ralf Duckeck, Volker Hiestermann, Hugh Milton, Kees
Wevers: "Rules for defining and referencing an
Intersection Location (ILOC); Detailed Location
Referencing (DLR) for ITS based on ILOCs's; draft report
of ERTICO Committee on Location Referencing, Version 0.8;
Brussels, Belgium; 14 April 1998.

5

10 Claims

1. Method for generating a location reference instance within a digital map comprising the steps of:

- 15 - identifying an object to be referenced
- determining the position of the object by its co-ordinates within the map,
- determining the object class of the object,
- identifying a descriptor of the object from common information stored in attributes, to verify the actual
- 20 object in case of more than one object satisfies a spatial range criteria and belongs to the same object class,
- coding the position of the object, the object class and the descriptor in a given format.

25

2. Method according to claim 1 by transmitting the generated location reference in the given format via a given transmission media.

30

3. Method according to claims 1 or 2 further comprising the steps of:

- decoding into position, the object class and the descriptor of the location reference data into a given system format, which can be different from the given
- 35 format,

- creating a search area dependent or independent of the decoded object class with a centre at the co-ordinates of the decoded position.
 - collecting all objects which are within the search area and within the decoded object class,
 - verifying the decoded/given descriptor with attributes or parts thereof of the collected objects
4. Method according to at least one of claims 1 and 3 further comprising the steps of:
- defining object classes which are suitable for traffic and telematic applications and based on doubtless information of reality.
 - assigning objects to object classes suitable for traffic and telematic applications and based on doubtless information of reality from all or some attributes of an object or related objects.
5. Method according to at least one of claims 1 to 4 further comprising the steps of:
- pre-processing a digital map by explicitly identifying object classes suitable for traffic and/or telematic applications and being based on doubtless information of reality from all or some attributes of an object or related objects to an attribute of such a classified object.

1/2

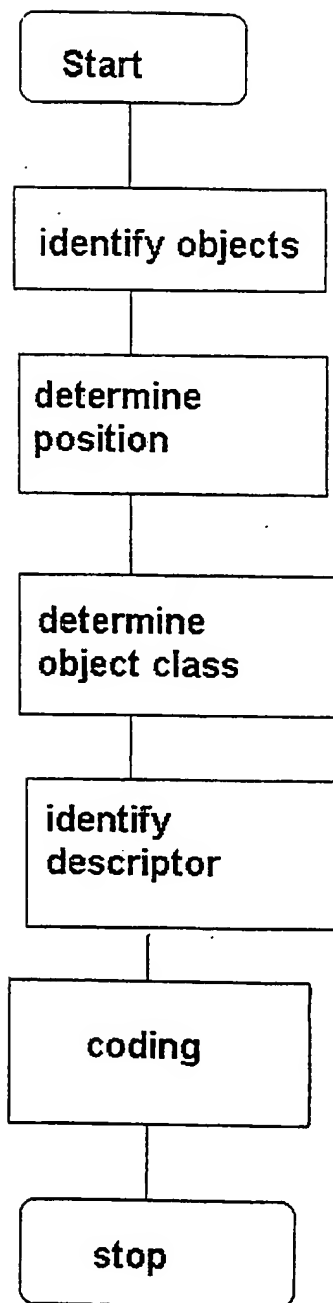


FIG. 1

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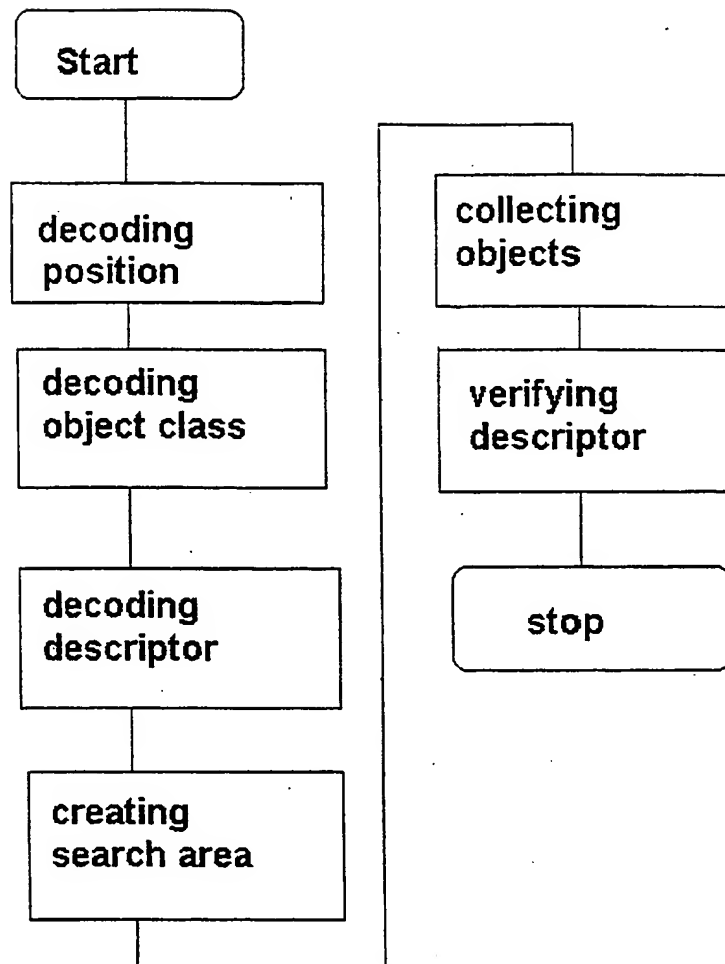


FIG. 2

INTERNATIONAL SEARCH REPORT

national Application No

PCT/EP 99/02820

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G08G1/0969

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 G08G G01C G09B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched.

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	---	3-5
Y	US 5 107 433 A (HELLDOERFER REINHARD ET AL) 21 April 1992 (1992-04-21) the whole document	1,2
A	---	3-5
A	US 4 677 561 A (AKAMA YASUYUKI ET AL) 30 June 1987 (1987-06-30) the whole document	1-5
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A	US 5 635 953 A (YOKOUCHI KAZUHIRO ET AL) 3 June 1997 (1997-06-03) -----	



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Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 99/02820

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